Identification and Modelling of a Distillation Column

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1 Introduction

Advanced control techniques such as Model Predictive Control (MPC), have been and are still heavily studied in the academic world. However, in industrial practice these techniques are still relatively scarcely exploited (and most often only in high tech or worldwide competing industries). Hence, it would be interesting to spread these techniques also in other industry branches. Therefore, in this research a proliferation of these methods is envisioned by implementing them using industry standard control hardware like Programmable Logic Controllers (PLCs). To test the possibilities of this hardware for MPC, a pilot scale distillation column is selected as a case study.

2 The distillation column

The distillation column under study concerns a pilot scale experimental set-up for the separation of a binary mixture of methanol and isopropanol. For practical reasons, the set-up is a closed system that mixes the two fractions again after separation. The column is a multiple input, multiple output (MIMO) system with four *manipulated variables* or *inputs* (i.e., reboiler duty, feed flow rate, feed temperature and distillate flow rate), and eleven *controlled variables* or *outputs* (i.e., distillate flow rate, feed flow rate and nine temperatures measurements between the bottom and the top of the column). The concentration of the top and bottom fraction is measured by taking samples at chosen intervals.

3 Modelling the column

To exploit MPC, a mathematical model of the column is required. Hereto, *black box* models are derived based on data driven techniques. Although the intension is to use in the future linear models around certain operating points, both linear and nonlinear models are fitted. After some first experiments with pseudo random binary noise (PRBS) input signals, a linear model has been calibrated [1]. However, since the system under study is a test set-up, all kinds of input signals can be used. Therefore, new experiments with random noise inputs will be used to refine the current linear model. Also a nonlinear model will be constructed with the help of Least Square Support Vector Machines (LS-SVM) [2]. LS-SVM is a state-of-the-art method for solving highly nonlinear modelling problems. Afterwards the constructed models will be employed to design the controller and to implement it on the column set-up.

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